

Claims

- [c1] 1.A system to control braking for a vehicle during a yaw stability control event, comprising:
a yaw stability control system to determine if the vehicle is experiencing an understeer or oversteer condition;
non-regenerative brakes connected to wheels of at least one axle;
regenerative braking is applied to the wheels of at least one axle; and
a controller comprising an ability to receive input from the yaw stability control system, compare actual brake balance to a desired brake balance, determine if front axle wheels or rear axle wheels are overbraked as compared to the desired brake balance, and adjust regenerative braking and non-regenerative braking levels.
- [c2] 2.The system of claim 1, wherein the controller is a simple proportional-integral-derivative feedback controller.
- [c3] 3.The system of claim 1, wherein the controller adjusts regenerative braking and non-regenerative braking levels over a period of time that provides a quick return to balanced braking and allows a switch between regenerative and non-regenerative braking to be smooth.
- [c4] 4.The system of claim 1, wherein the controller adjusts regenerative braking and non-regenerative braking levels over a period of time between 50 msec and 1 sec.
- [c5] 5.The system of claim 1, wherein:
the non-regenerative brakes are connected to front axle wheels; and
regenerative braking is applied to rear axle wheels.
- [c6] 6.The system of claim 5, wherein:
the controller reduces regenerative braking when the yaw stability control system determines the vehicle is experiencing said oversteer condition and the rear axle wheels are overbraked relative to the front axle wheels.
- [c7] 7.The system of claim 5, wherein:
the controller maintains regenerative braking when the yaw stability control

system determines the vehicle is experiencing said understeer condition.

[c8] 8.The system of claim 5, wherein:
the controller maintains regenerative braking when the yaw stability control system determines the vehicle is experiencing said oversteer condition and the rear axle wheels are not overbraked relative to the front axle wheels.

[c9] 9.The system of claim 5, wherein:
the non-regenerative brakes are also connected to the rear axle wheels; and
the controller switches from regenerative braking to non-regenerative braking at the rear axle wheels when the yaw stability control system determines the vehicle is experiencing said understeer condition.

[c10] 10.The system of claim 5 wherein:
the non-regenerative brakes are also connected to the rear axle wheels; and
the controller switches from regenerative braking to non-regenerative braking at the rear axle wheels when the yaw stability control system determines the vehicle is experiencing said oversteer condition and the rear axle wheels are not overbraked relative to the front axle wheels.

[c11] 11.The system of claim 1, wherein:
the non-regenerative brakes are connected to rear axle wheels; and
regenerative braking is applied to front axle wheels.

[c12] 12.The system of claim 11, wherein:
the controller reduces regenerative braking when the yaw stability control system determines the vehicle is experiencing said understeer condition and the front axle wheels are overbraked relative to the rear axle wheels.

[c13] 13.The system of claim 11, wherein:
the controller maintains regenerative braking when the yaw stability control system determines the vehicle is experiencing said oversteer condition.

[c14] 14.The system of claim 11, wherein:
the controller maintains regenerative braking when the yaw stability control system determines the vehicle is experiencing said understeer condition and the

front axle wheels are not overbraked relative to the rear axle wheels.

- [c15] 15.The system of claim 11, wherein:
the non-regenerative brakes are also connected to the front axle wheels; and
the controller switches from regenerative braking to non-regenerative braking
at the front axle wheels when the yaw stability control system determines the
vehicle is experiencing said oversteer condition.
- [c16] 16.The system of claim 11, wherein:
the non-regenerative brakes are also connected to the front axle wheels; and
the controller switches from regenerative braking to non-regenerative braking
at the front axle wheels when the yaw stability control system determines the
vehicle is experiencing said understeer condition and the front axle wheels are
not overbraked relative to the rear axle wheels.
- [c17] 17.A method to control regenerative braking for a vehicle having a yaw stability
control system, an ability to provide regenerative braking torque to wheels of at
least one axle, non-regenerative brakes connected to the wheels of at least one
axle, the method comprising the steps of:
determining in the yaw stability control system if the vehicle is experiencing an
understeer or oversteer condition; and
controlling the vehicle by receiving input from the yaw stability control system,
comparing actual brake balance to a desired brake balance, determining if front
axle wheels or rear axle wheels are overbraked as compared to the desired
brake balance, and adjusting regenerative braking and non-regenerative
braking levels.
- [c18] 18.The method of claim 17, wherein the step of controlling the vehicle
comprises using a simple proportional-integral-derivative feedback controller.
- [c19] 19.The method of claim 17, wherein the step of adjusting regenerative braking
and non-regenerative braking levels is accomplished over a period of time that
provides a quick return to balanced braking and allows a switch between
regenerative braking and non-regenerative braking to be smooth.
- [c20] 20.The method of claim 17, wherein the step of adjusting regenerative braking

and non-regenerative braking levels is accomplished over a period of time between 50 msec and 1 sec.

- [c21] 21.The method of claim 17, wherein:
regenerative braking is applied to the rear axle wheels; and
the non-regenerative brakes are connected to the front axle wheels.
- [c22] 22.The method of claim 21, wherein the step of adjusting regenerative braking and non-regenerative braking levels comprises the step of:
reducing regenerative braking when the yaw stability control system determines the vehicle is experiencing said oversteer condition and the rear axle wheels are overbraked relative to the front axle wheels.
- [c23] 23.The method of claim 21, wherein the step of adjusting regenerative braking and non-regenerative braking levels comprises the step of:
maintaining regenerative braking when the yaw stability control system determines the vehicle is experiencing said understeer condition.
- [c24] 24.The method of claim 21, wherein the step of adjusting regenerative braking and non-regenerative braking levels comprises the step of:
maintaining regenerative braking when the yaw stability control system determines the vehicle is experiencing said oversteer condition and the rear axle wheels are not overbraked relative to the front axle wheels.
- [c25] 25.The method of claim 21, wherein:
the non-regenerative brakes are also connected to the rear axle wheels; and
the step of adjusting regenerative braking and non-regenerative braking levels comprises switching from regenerative braking to non-regenerative braking at the rear axle wheels when the yaw stability control system determines the vehicle is experiencing said understeer condition.
- [c26] 26.The method of claim 21, wherein:
the non-regenerative brakes are also connected to the rear axle wheels; and
the step of adjusting regenerative braking and non-regenerative braking levels comprises switching from regenerative braking to non-regenerative braking at the rear axle wheels when the yaw stability control system determines the

vehicle is experiencing said oversteer condition and the rear axle wheels are not overbraked relative to the front axle wheels.

- [c27] 27.The method of claim 17, wherein:
regenerative braking is applied to the front axle wheels; and
the non-regenerative brakes are connected to the rear axle wheels.
- [c28] 28.The method of claim 27, wherein the step of adjusting regenerative braking and non-regenerative braking levels comprises the step of:
reducing regenerative braking when the yaw stability control system determines the vehicle is experiencing said understeer condition and the front axle wheels are overbraked relative to the rear axle wheels.
- [c29] 29.The method of claim 27, wherein the step of adjusting regenerative braking and non-regenerative braking levels comprises the step of:
maintaining regenerative braking when the yaw stability control system determines the vehicle is experiencing said oversteer condition.
- [c30] 30.The method of claim 27, wherein the step of adjusting regenerative braking and non-regenerative braking levels comprises the step of:
maintaining regenerative braking when the yaw stability control system determines the vehicle is experiencing said understeer condition and the front axle wheels are not overbraked relative to the rear axle wheels.
- [c31] 31.The method of claim 27, wherein:
the non-regenerative brakes are also connected to the front axle wheels; and
the step of adjusting regenerative braking and non-regenerative braking levels comprises switching from regenerative braking to non-regenerative braking at the front axle wheels when the yaw stability control system determines the vehicle is experiencing said oversteer condition.
- [c32] 32.The method of claim 27, wherein:
the non-regenerative brakes are also connected to the front axle wheels; and
the step of adjusting regenerative braking and non-regenerative braking levels comprises switching from regenerative braking to non-regenerative braking at the front axle wheels when the yaw stability control system determines the

vehicle is experiencing said understeer condition and the front axle wheels are not overbraked relative to the rear axle wheels.

- [c33] 33. An article of manufacture to control regenerative braking for a vehicle comprising:
- a yaw stability control system;
 - an ability to provide regenerative braking torque to wheels of at least one axle;
 - non-regenerative brakes connected to the wheels of at least one axle;
 - a controller; and
 - a control system embodied within the controller for directing the controller to control regenerative braking and non-regenerative braking during operation of the yaw stability control system.

- [c34] 34. An automotive vehicle, comprising:
- a yaw stability control system;
 - an ability to provide regenerative braking torque to wheels of at least one axle;
 - non-regenerative brakes connected to the wheels of at least one axle;
 - a controller; and
 - a control system embodied within the controller for directing the controller to control regenerative braking and non-regenerative braking during operation of the yaw stability control system.

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